the more northern part. Dr. Scheiner's photographs show that its extension southward is very considerable, but, owing to its dimness, was not seen by Prof. Barnard. The form of this nebula, a copy of which is given in this number, is inclined to be spirally, although not so apparent as that of Andromeda, and, curiously enough, it lacks a bright nucleus, as in the latter.

MINOR PLANETS.—The work of discovering minor planets seems, at the present time of the year, to be in a very flourishing condition, although rather restricted to two observers, according to the current number of *Astronomische Nachrichten* (No. 3157). Charlois with 10 and Wolf with 2, bringing the present notation up to 1893 *x*, is a good number for the first quarter of the year, and if this average be kept up we shall soon be driven to indulge in the Greek or German alphabet, or both.

## GEOGRAPHICAL NOTES.

MR. JOHN BARTHOLOMEW, of Edinburgh, whose reputation as one of the foremost British map-makers is world-wide, died on March 30, at the age of 61. His career will be remembered as an epoch in the history of the perfecting and popularising of English maps. Trained in Edinburgh and afterwards under the late Dr. Petermann, in London, Mr. Bartholomew succeeded his father in a cartographical business in Edinburgh, which he steadily enlarged and improved, paying attention not only to excellence of mechanical production, but to the improvements of methods of representation. But the leading characteristic of Mr. Bartholomew's work was his conscientious endeavour to produce the most accurate topographical delineation. The general use of maps coloured orographically in this country is mainly due to the efforts of the Edinburgh Geographical Institute, of which he was the head. Mr. Bartholomew gradually withdrew from active work on account of failing health, and his son, Mr. J. G. Bartholomew, has taken his place in the Geographical Institute.

MR. THEODORE BENT (see p. 519) has been able to reach Aksum, where, however, he only remained for eight days, on account of tribal wars. The party had to retire abruptly because of a threatened fight, in which they were very nearly compelled to take sides, but fortunately the report of an advance of Italian troops to their relief solved the difficulty, and they reached the coast in safety. Despite the shortness of the working time, some good archæological results have been obtained.

THE March number of *Petermann's Mitteilungen* contains a valuable paper on North-west Patagonia by Dr. J. von Siemiradzki, with a map showing the results of his surveys and coloured to bring out the pastoral possibilities of the region. His route in 1891–92 led up the Rio Negro and Rio Limay to Lake Nahuel-Huapi and thence northward through the grassy valleys and bare slopes of the Cordillera to the Upper Biobio valley, whence the expedition passed to the coast of Chile.

THE Royal Geographical Society has given a grant to Dr. H. R. Mill to defray the expenses of a careful bathymetrical survey of some of the larger English lakes. The work, which will be carried out next summer, would be greatly facilitated if use could be had for a few days of a steam launch upon any of the lakes. Windermere, Coniston Water, and Wastwater will probably be sounded in the first place, as they are the most interesting from the limnological point of view.

A PAPER on the Geography and Social Conditions of the Iberian Peninsula read at the March meeting of the Berlin Geographical Society by Prof. Theobald Fischer is published in abstract in the April number of the *Geographical Journal*. The paradoxical character of the peninsula in the variety of its conditions has long been known. The great central plateau with its broken mountain border sloping steeply to the sea throws the bulk of the population towards the coast-line. In the border zone of the peninsula comprising 45 per cent. of its area, more than 66 per cent. of the inhabitants are settled. The only large city in the central plains is Madrid; all the rest of the plateau is occupied by wheat-growers and sheep-rearers; the mining, fruit-growing and industrial interests being all confined to the seaward slopes. There are few parts of Europe in which the physical conditions so plainly dominate the whole character of a country.

## GRAPHICAL SOLUTIONS OF PROBLEMS IN NAVIGATION.

1. IF we suppose the two angles P, S of a spherical triangle SPZ to be together less than two right angles, a plane triangle $S_1P_1Z_1$ may clearly be drawn such that $P_1 = P$ and $S_1 = S$. The sides of the spherical triangle PS, PZ, SZ being respectively denoted by $p$, $c$, $z$, those of the plane triangle may be taken in the following ratios:—

$$P_1S_1 = \tan \tfrac{1}{2}p,$$

$$P_1Z_1 = \tfrac{1}{2} \tan \tfrac{1}{2}(c + z) + \tfrac{1}{2} \tan \tfrac{1}{2}(c - z),$$

$$S_1Z_1 = \tfrac{1}{2} \tan \tfrac{1}{2}(c + z) - \tfrac{1}{2} \tan \tfrac{1}{2}(c - z),$$

These results may be easily verified.

Hence $$S_1Z_1 + P_1Z_1 = \tan \tfrac{1}{2}(c + z),$$

and $$P_1Z_1 - S_1Z_1 = \tan \tfrac{1}{2}(c - z).$$

From these equations we infer that $Z_1$ is the intersection of an ellipse and hyperbola which have the same foci $P_1$ and $S_1$. Suppose now that the line $S_1P_1$ contains, say, 100 divisions, and that a system of ellipses, having $S_1$ and $P_1$ as foci, with major axes 101, 102, 103 . . . and a system of hyperbolas whose axes are 99, 98, 97 . . . are drawn on one side of $S_1P_1$; then, by finding $m_1$, $m_2$ from the equations

$$m_1 = 100 \tan \tfrac{1}{2}(c + z) \cot \tfrac{1}{2}p,$$

$$m_2 = 100 \tan \tfrac{1}{2}(c - z) \cot \tfrac{1}{2}p,$$

we should be able to localise the point $m_1m_2$ as coming between two successive ellipses and also between two consecutive hyperbolas in the diagram.

2. The usefulness of such a diagram lies in its application to problems in navigation. For $p$ may be taken as the north polar distance of the sun, $z$ the complement of his altitude, and $c$ the colatitude of the place of observation. Having determined $m_1$, $m_2$ and thus localised $Z_1$ in the diagram, the angle $Z_1P_1S_1$ is the hour angle which may be suitably measured.

If we interchange $p$ and $c$ in the diagram, thus making $P_1$ and $Z_1$ the foci, the point to be localised is $S_1$ from the equations

$$n_1 = 100 \tan \tfrac{1}{2}(p + z) \cot \tfrac{1}{2}c,$$

$$n_2 = 100 \tan \tfrac{1}{2}(p - z) \cot \tfrac{1}{2}c.$$

The difficulties attending this mode of representation will present themselves in another form in § 4. It is sufficient to notice here that this use of the diagram has the advantage of giving two useful angles—$S_1P_1Z_1$, the hour angle, and $S_1Z_1P_1$ the azimuth.

3. The merit of both these modes of representation consists in their being each a single diagram, applicable at any time of year, though in northern latitudes more favourable to accurate measures in summer than in winter. Their demerit consists in the preliminary calculations of $m_1$, $m_2$, or $n_1$, $n_2$. This, however, might be minimised by supplying, along with the diagram, tables of the values of $m$ for two arguments $\theta$ and $\phi$ given by

$$m = 100 \tan \tfrac{1}{2} \theta \cot \tfrac{1}{2} \phi$$

The whole amount of preliminary calculation would then consist in adding and subtracting $p$ and $z$, and looking out $m_1$ and $m_2$.

I shall now investigate the nature of a diagram which requires no preliminary calculation.

Returning to the spherical figure SPZ, let us suppose SP to be fixed while the sides PZ, SZ vary so that Z describes a curve on the sphere. The corresponding point $Z_1$ will describe a corresponding locus on the plane. For example, if L describes a small circle with P as centre, the locus of $Z_1$ will be given by

$$\tan c = \tan\{\tfrac{1}{2}(c + z) + \tfrac{1}{2}(c - z)\}$$

$$= \frac{P_1Z_1}{1 - P_1Z_1^2 + S_1Z_1^2}.$$

Now, if we draw a perpendicular $Z_1N$ to the side $P_1S_1$ we shall have

$$P_1S_1^2 - S_1Z_1^2 = P_1N^2 - S_1N^2$$

$$= \tan \tfrac{1}{2}p(2P_1N - \tan \tfrac{1}{2}p);$$

$$\therefore\ P_1Z_1 = \tan c \tan \tfrac{1}{2}p(\operatorname{cosec} p - P_1N).$$

This shows that the curve described by $Z_1$ is a conic section of eccentricity $\tan c \tan \tfrac{1}{2}p$, with focus at $P_1$ and directrix perpendicular to $P_1C_1$ at a distance cosec $p$ from $P_1$.

Similarly, the curves corresponding to small circles about $S_1$ are conics with a common directrix and with focus at $S_1$, their curvatures being turned the opposite way from those about $P_1$.

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The lines whose focus is $P_1$ are curves of equal latitude, and those whose focus is $S_1$ are Sumner lines. Suppose systems of both kinds of lines to be drawn, the figure will be divided into small quadrilaterals, and the eye, aided by a scale with small divisions, would approximately determine the point within any quadrilateral at which the values of $c$ and $z$ are given, intermediate between those of the bounding sides. It is difficult to estimate the error to which this determination would be liable, but supposing the linear dimensions of a quadrilateral at a distance of 10 inches from $P_1$ were comparable with the tenth of an inch and that an error of one-hundreth of an inch were committed in the direction $\perp^r$ to $P_1Z_1$, this would mean an error of 3 or 4 minutes in the measured value of the hour angle. This error would be important, but not large enough to condemn the method, and the estimate shows that the scale of the diagram should be as large as is practicable.

If we confine the diagram to points in north latitudes $c$ may be taken to range between 30° and 90°, though it would obviously be desirable also to draw a few lines for which $c$ is $>90°$. The range of $z$ may be taken between 10° and 80°. The distance between the foci is, as we have seen, $\tan \frac{1}{2} p$ and the distance between the directrices is readily proved to be $\cot \frac{1}{2} p$. The consideration which determines the scale on which the curves should be drawn is that the Sumner for which $z = 80°$ should appear in the diagram as far as it may be required.

The curves in each diagram are different from those in every other for different values of $p$; for although it might at first appear that since the distance from the focus to the directrix is the same for $180° - p$ as it is for $p$ some saving would be effected, the indications of the same curves in the two cases are different, and the Sumners are placed differently in regard to the parallels of latitude. In the case of the sun a diagram for every ten minutes change in declination would probably be necessary, and this would mean an enormous amount of work. Diagrams for a few of the best stars could, however, be constructed on this principle and would be extremely useful.

It will have been noticed that the angle $Z_1S_1P_1$ is equal to the angle ZSP in the spherical figure, but the azimuth is not represented in the plane figure. The following properties of the plane curves may therefore be stated:—

(1) The angle at which $S_1Z_1$ cuts the sumner at $Z_1$ is equal to the angle at which $P_1Z_1$ cuts the parallel of latitude.

(2) If a tangent at $Z_1$ be drawn to either curve, say the sumner, to cut $S_1P_1$ in T and perpendiculars be drawn from T to $Z_1P_1$, $Z_1S_1$ meeting them in M and N, then

$$\cos(\text{azimuth}) = \mp \frac{\text{TM}}{\text{TN}}$$

according as T falls between $S_1$ and $P_1$ or not. From this result a graphical determination of the azimuth is easily obtained.

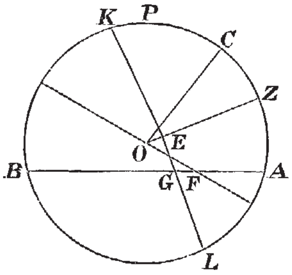
4. If we take $Z_1P_1$ for base line the curves to be drawn are curves of altitude and polar distance. This method of representation is tempting as the angles at $P_1$ and $Z_1$ are then the hour angle and azimuth. Moreover it would be a very convenient way of producing the diagrams to arrange them for consecutive values of the colatitude. Unfortunately there are serious objections. Suppose the common directrix of the polar distance lines cuts $P_1Z_1$ produced in X, then when the sun is in the southern hemisphere these lines are hyperbolas on the remote side of the directrix from $P_1$ and they diverge rapidly for consecutive values of $p > 90°$; so much so that, when the colatitude is between 30° and 40°, it is impossible to represent them on a scale which would be of any value. For places in the tropics there would not be the same objection, and diagrams drawn on this principle would be convenient in those regions.

There is another difficulty. In winter, in northern latitudes, the azimuth and hour angle may be together greater than two right angles or, what is equivalent, $p + z$ may be $>180°$. In that case the construction we are going upon fails, although it is possible to meet the difficulty.

The point is interesting, and admits of the following explanation:—In the figure P is the north pole, Z the place of observation, AB the diurnal path of the sun. If C be the middle point of PZ, then all points above the plane through the centre O perpendicular to OC may appear in the plane diagram supposed large enough. Again a plane KL perpendicular to OZ corresponding to $z = 80°$ limits the area in which observations may be taken. If, therefore, the sun were observed between F and G he would be out of the diagram, and this means that $p + z > 180°$.

The difficulty may be overcome by solving graphically another triangle $S_1{}^1P_1Z_1$ corresponding to $S^1PZ$ in the spherical figure where $S^1$ is diametrically opposite to S. For, if $SZP + SPZ > 180°$ then $S^1PZ + S^1PZ < 180°$. Hence, if we interchange $Z_1$ and $P_1$ in the diagram and pick out the intersection of the curves $180° - z$ and $180° - p$ we shall thereby find graphically the supplements of the hour angle and azimuth.

5. To these modes of representation may be added stereographic projection on the plane of the equator which admits of lines of equal latitude and Sumner lines being represented by systems of circles and of two angles of the spherical triangle being represented in the corresponding plane figure.



6. The object of all such methods is to facilitate the drawing of lines of position on a Mercator's chart, and as the hour angle must be determined with the greatest possible precision, the diagram should be on a large scale with hour angle lines drawn upon it at suitable intervals.

With this in mind the most practical of the foregoing methods would seem to be the first, viz. that in which there is a single diagram, cut into sections, not necessarily on the same scale, but large enough to admit of the hour angle lines and perhaps also azimuth lines being drawn upon it.

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## *ANTHROPOLOGICAL USES OF THE CAMERA.*

An interesting paper on the anthropological uses of the camera was lately read by Mr. E. F. im Thurn before the Anthropological Institute of Great Britain and Ireland, and is now reprinted in the Institute's "Journal."

Mr. im Thurn points out that primitive phases of life are fast fading from the world in this age of restless travel and exploration, and urges that it should be recognised as almost the duty of educated travellers in the less known parts of the world to put on permanent record, before it is too late, such of these phases as they may observe. It is certainly, however, he says, not a sufficiently recognised fact that such records, usually made in writing, might be infinitely helped out by the camera.

As illustrating the small use of the camera for this special purpose, Mr. im Thurn calls attention to the almost universal badness of illustrations of living primitive folk in books of anthropology and travel, when these illustrations are not merely what may be called physiological pictures. Of old the book illustrator, if, as was usual, he was not himself the traveller, drew as pictures of primitive folk, merely the men and women that surrounded him, drew figures of men and women of his own stage of civilisation, and merely added to these such salient features as he was able, from the traveller's tales, to fancy that his supposed primitive subjects had. So in 1599 the imaginative artist of Nuremberg who drew the pictures for the rare Latin abbreviation of Sir Walter Raleigh's "Discoverie of Guiana" gave to the world his impressions of the "Amazons," the "Headless Men," and the "Men who dwelt on trees" which are typical of the pictures of "savages" which adorn the travellers' books up to nearly the present century.

Mr. im Thurn refers also to the beautifully executed illustrations by Bartolozzi in Stedman's "Dutch Guiana," in which, in place of natives, are shown, with the necessary change of dress, simply Europeans of more than average beauty of form. There were doubtless exceptions to the misrepresentation of primitive folk, and the greatest of these exceptions known to Mr. im Thurn is the beautiful series of drawings by Catlin of North American Redmen. But Catlin enjoyed the unusual advantage not only of considerable technical skill as an artist,

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